



DEVELOPMENT OF ICE/NO-ICE SENSOR SYSTEM FOR IN-FLIGHT ICE DETECTION

Randy Wallace: Goodrich DSSD

Galdemir Botura: Goodrich DSSD



Outline

- ✈ Abstract
- ✈ Introduction
- ✈ System Development Overview
- ✈ Operational Envelope
- ✈ Component Architecture
- ✈ Hardware Description
- ✈ Development Testing
- ✈ Conclusions



Abstract

- Goodrich Corporation is a leader in the development and manufacturing of ice protection and detection systems.
- The Ice/No-Ice Sensor System (INISS) addresses the detection of the onset of icing on Aircraft. A robust sensor was developed and manufactured to meet wear and erosion requirements. The INISS can be used to provide automated control of ice protection systems.
- The INISS minimizes the time an ice protection system is on.
- Test results have demonstrated the INISS capability to determine onset of icing on many airfoil shapes, including unprotected areas susceptible to freezing drizzle or freezing rain (SLD).



Introduction

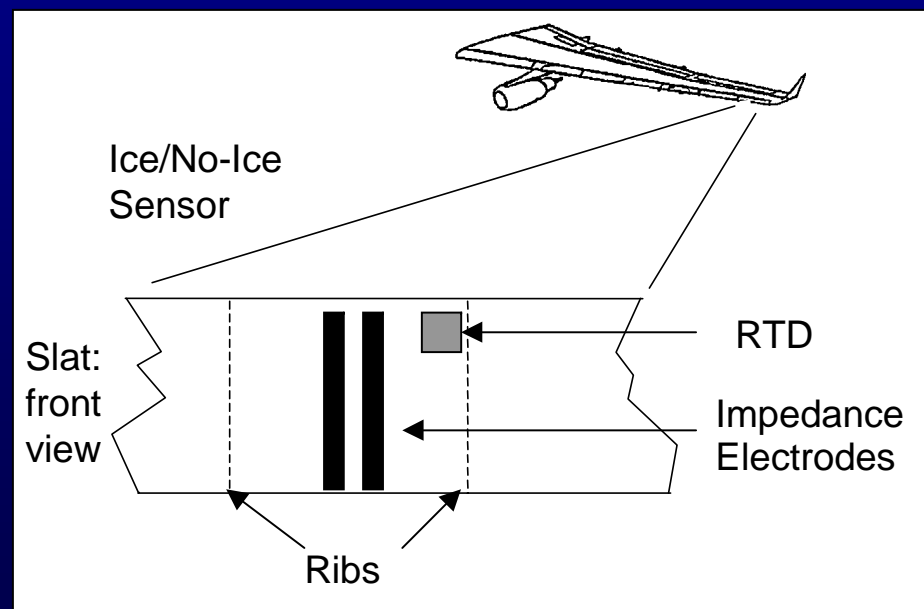
INISS Performance benefits include:

- ◆ Can be installed integral to leading edge or placed directly on the surface
- ◆ Direct measurement of ice build-up on areas of interest
- ◆ Ice detection capability over flat or curved surfaces.
- ◆ Sensor detection area can be tailored for each specific application
- ◆ Detection of as little as 0.020 inch of nominal ice build up.
- ◆ Integration capability with any ice protection system
- ◆ Installation without airplane structural changes
- ◆ Aerodynamically flush
- ◆ Residual ice feedback capability
- ◆ Advisory or Primary ice detection



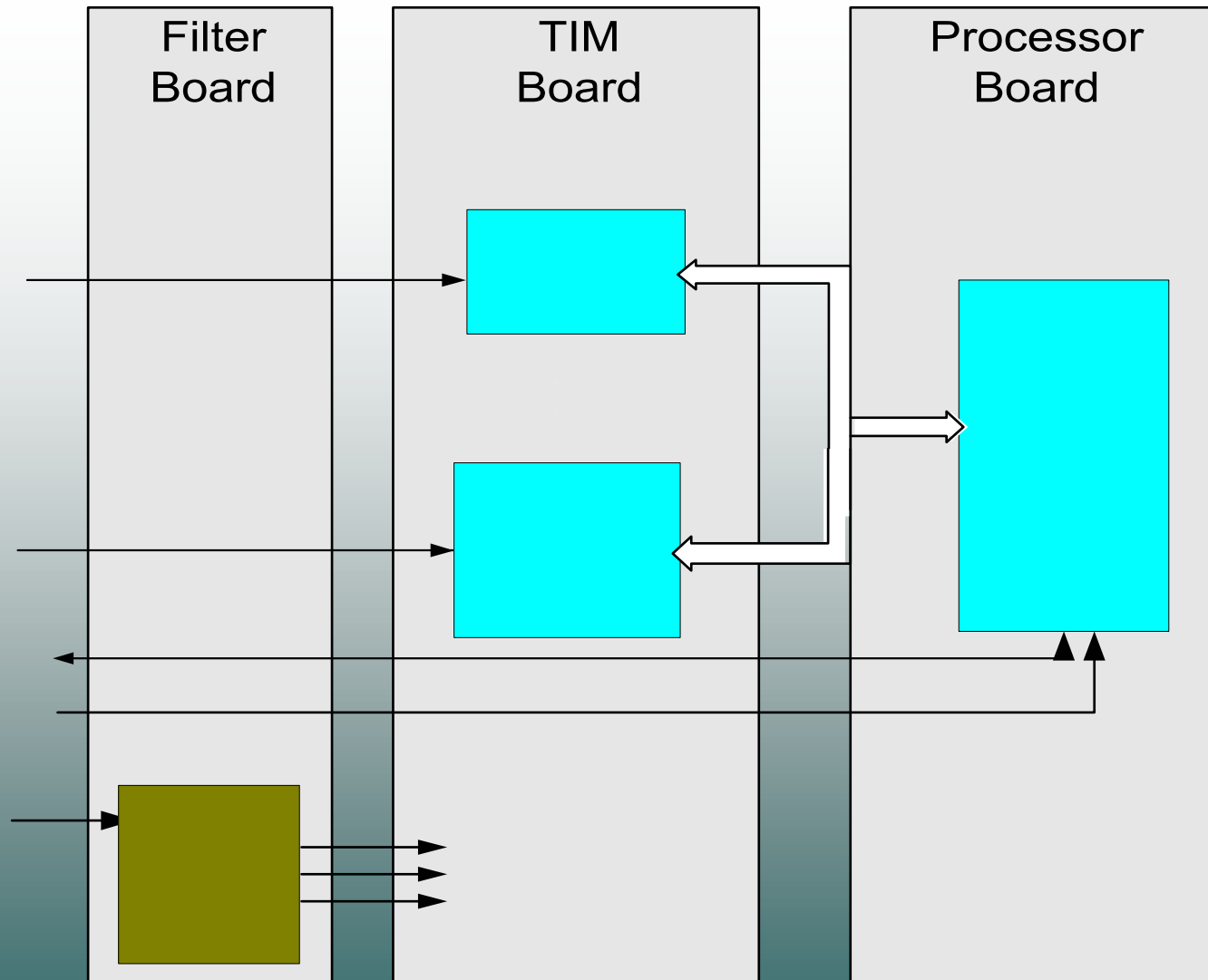
System Development Overview

- ✦ SMARTBoot™ System developed and STC for Piper Malibu and Mirage 1997
- ✦ Ice No/Ice System (INISS) developed as a derivative of the SMARTBoot™ System
- ✦ Current Applications include GA and UAV's





Component Architecture

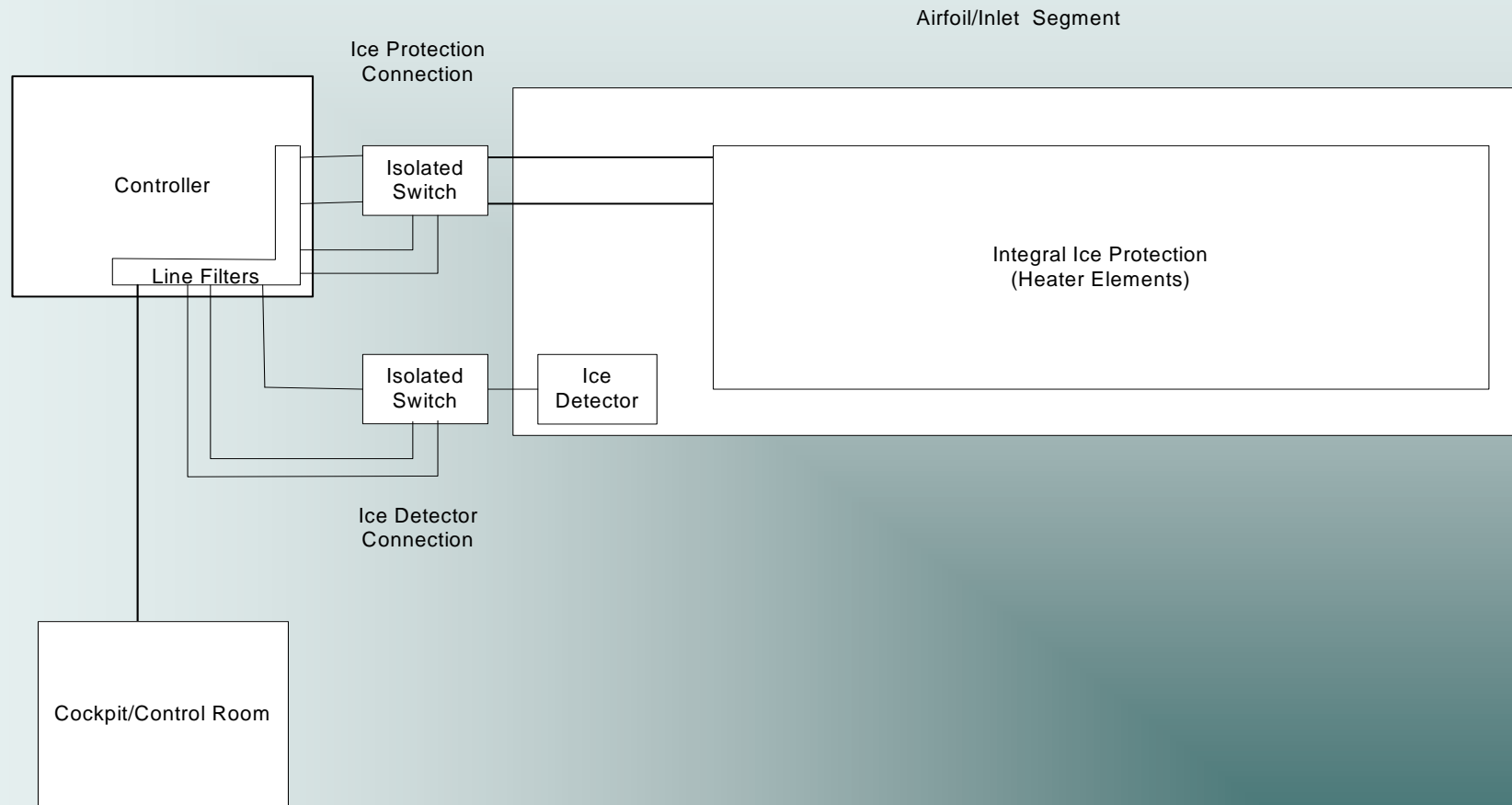


FAA In-Flight Icing/Ground De-Icing Conference

Impedance



Lightning Protection Control





INISS Components



*Integrated Sensor
and Electronic
Control Unit*



*Metallic Electrodes
Integrated Into Surface
of Composite Airfoil*



*Elastomeric Sensor
Integrated Into Surface
of a Composite Airfoil*



Operational Envelope

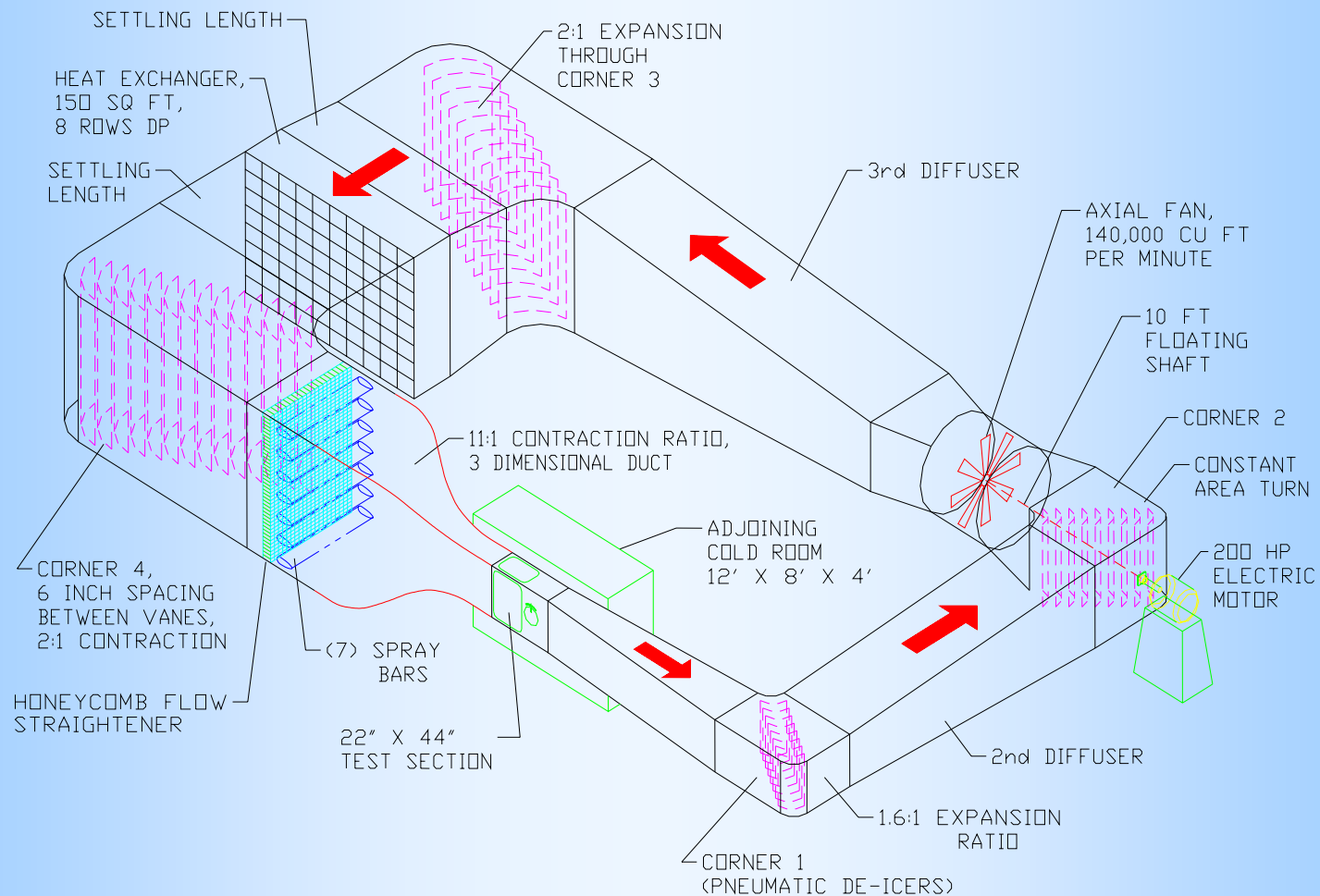
INISS Operating / Non-Operating Temperature Range

Component	Operating Range	Non-Operating Range
Sensor	-67°F to +212°F	-76°F to +212°F
Controller	-40°F to +160°F	-67°F to +160°F



Development Testing

GOODRICH ICING WIND TUNNEL

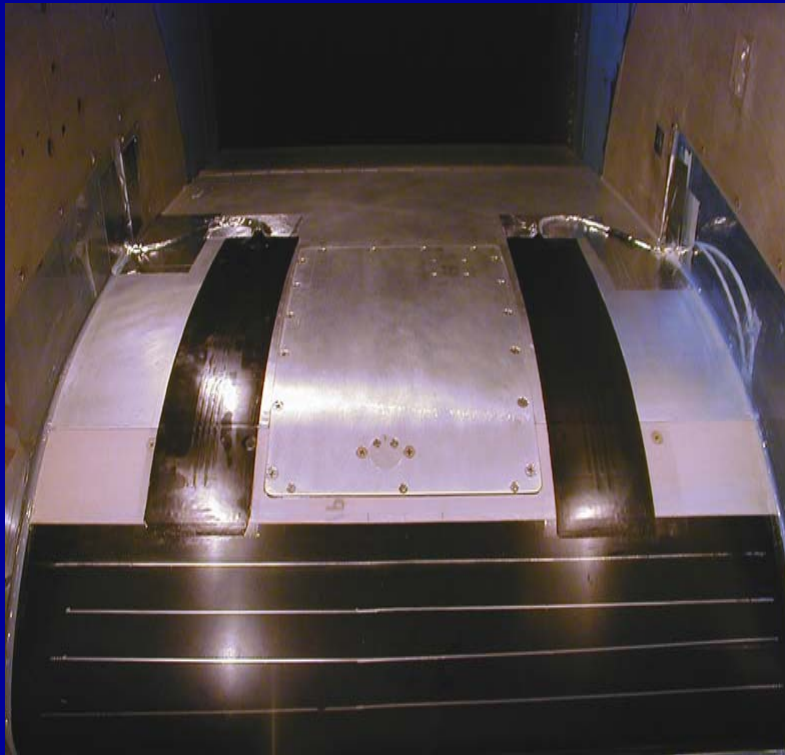


FAA In-Flight Icing/Ground De-Icing Conference

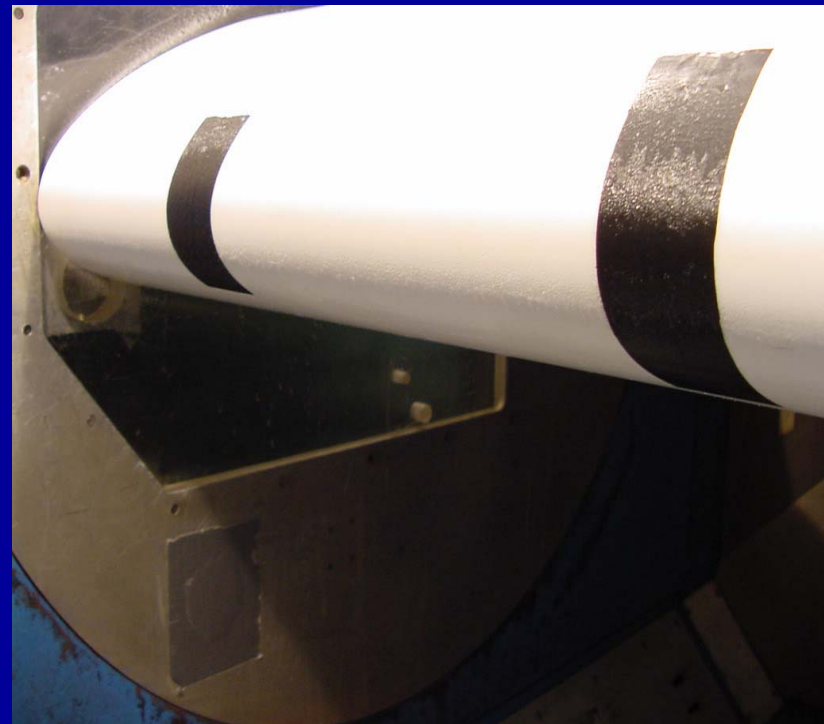


Development Testing

Metallic Airfoil - NACA 23012
Ice Sensing of Simulated SLD



Ice Sensing on a Non-Protected
Composite Airfoil



FAA In-Flight Icing/Ground De-Icing Conference



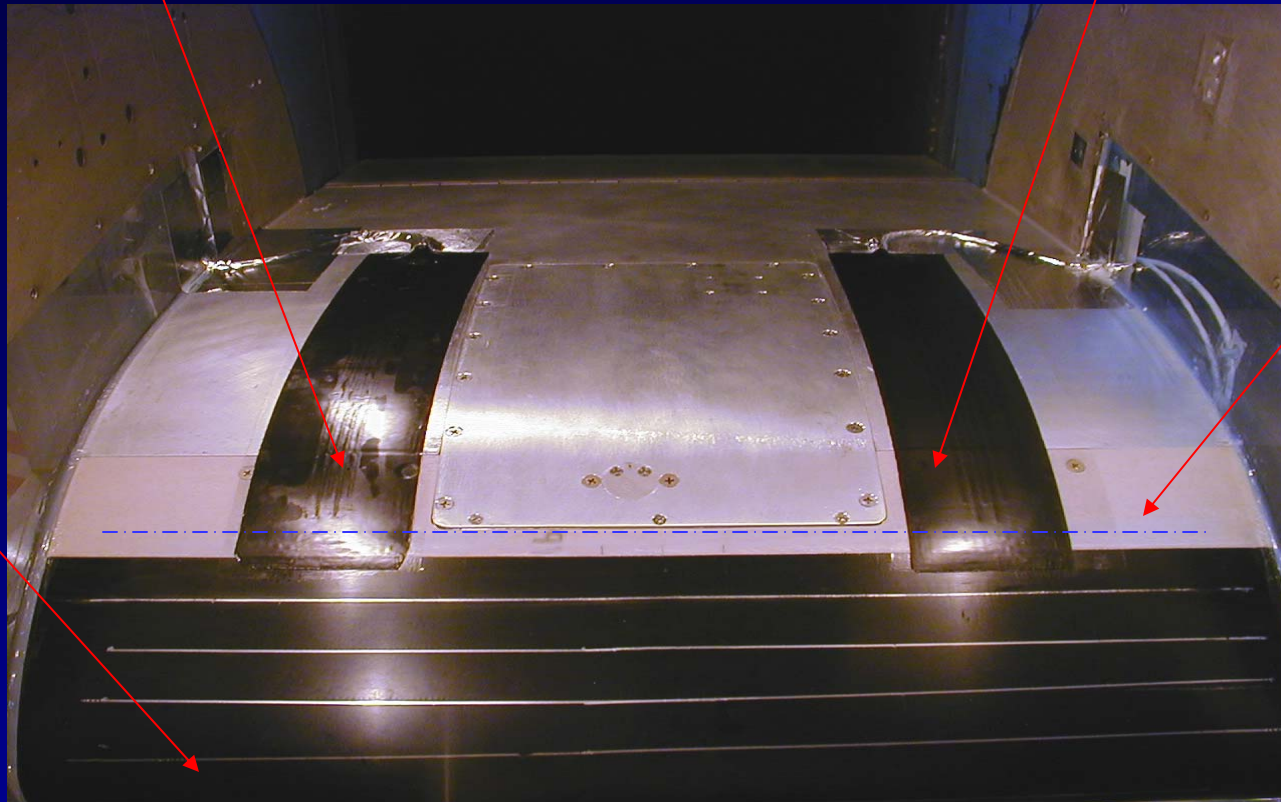
Development Testing

INISS
Sensor

INISS
Sensor

Pneumatic
De-icer

Boundary
Sensing
Zone



INISS Detector Installation

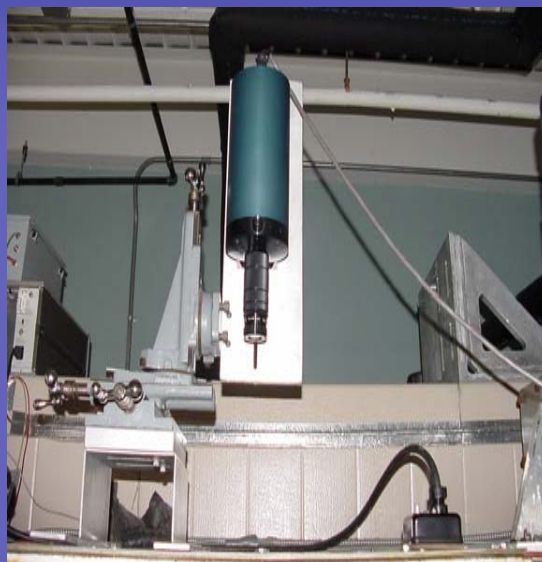
FAA In-Flight Icing/Ground De-Icing Conference



Development Testing



System Control
and Monitoring



Ice Thickness
Monitoring

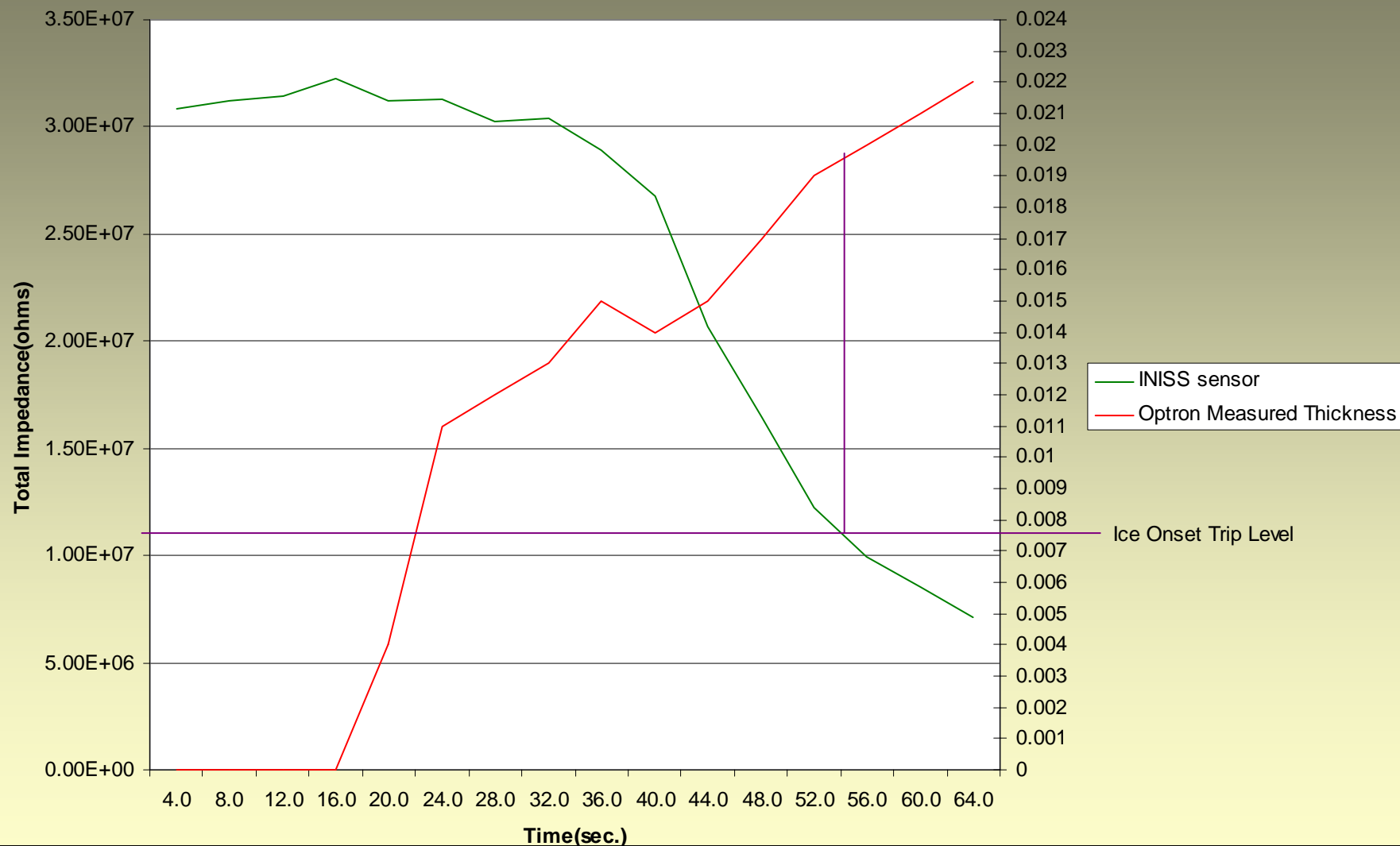


Data
Acquisition



Development Testing

Run 112701.012 154 MPH, 0 AOA, 20 MVD, 25 F, .52 LWC



FAA In-Flight Icing/Ground De-Icing Conference



Conclusions

- Test results have show that the INISS performance was proven effective for all conditions tested. Testing the INISS sensor in varying airfoil locations demonstrated the versatility of the system to detect ice for multiple applications.
- The sensor's ease of integration in an airfoil surface allows for effective ice detection at the surface of interest.
- Tests have shown INISS capability to detect thin layers of ice on the leading edge, .02" to .03 " measured
- The sensor can be tailored for specific applications. Versatility allows sensor installation in needed areas. Testing INISS detects very thin layers of ice, ideal for detecting onset of icing conditions.

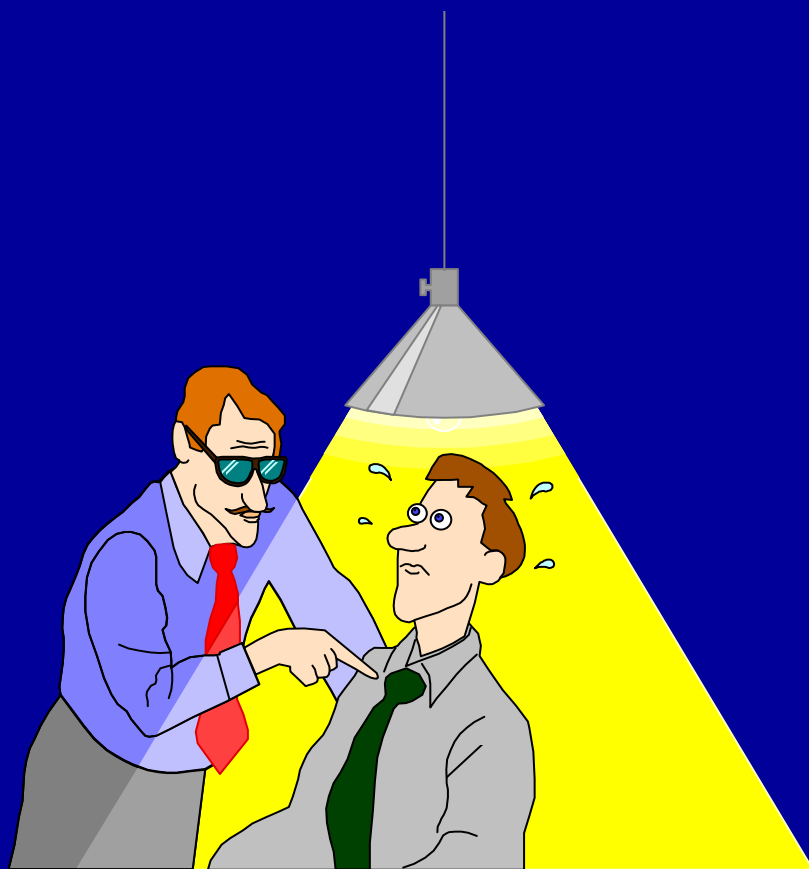


Conclusions

- The INISS signal can be used to activate an ice protection system. Also, the INISS can be used to detect icing conditions outside of Far Part 25 Appendix C, where freezing rain and drizzle may cause ice accretion aft of protected regions.
- The INISS can be easily fitted to any existing application. The results are promising for continued integration of the INISS into various aircraft and engine configurations.



QUESTIONS and ANSWERS



FAA In-Flight Icing/Ground De-Icing Conference